

## **Partnership for Science & Engineering Practices**

*Protocol for Unit Enhancement of Explanation and Argumentation- Grades 3-5*

### **Part 1 Overview of Explanation and Argumentation in NGSS**

*Read the text below as a reminder of the practices of explanation and argumentation in grades 3-5.*

*Also examine the way that explanation and argumentation are present in the NGSS performance expectations.*

#### **Practice 6 Constructing Explanations and Designing Solutions:**

The goal of science is to construct explanations for the causes of phenomena. Students are expected to construct their own explanations, as well as apply standard explanations they learn about from their teachers or reading. The Framework states the following about explanation:

“The goal of science is the construction of theories that provide explanatory accounts of the world. A theory becomes accepted when it has multiple lines of empirical evidence and greater explanatory power of phenomena than previous theories.”(NRC Framework, 2012, p. 52)

An explanation includes a claim that relates how a variable or variables relate to another variable or a set of variables. A claim is often made in response to a question and in the process of answering the question, scientists often design investigations to generate data. The goal of engineering is to solve problems. Designing solutions to problems is a systematic process that involves defining the problem, then generating, testing, and improving solutions. This practice is described in the Framework as follows.

*Asking students to demonstrate their own understanding of the implications of a scientific idea by developing their own explanations of phenomena, whether based on observations they have made or models they have developed, engages them in an essential part of the process by which conceptual change can occur.*

#### **Explanation in Grade 3-5**

Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.

- Construct an explanation of observed relationships (e.g., the distribution of plants in the back yard).
- Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.
- Identify the evidence that supports particular points in an explanation.

#### **Practice 7 Engaging in Argument from Evidence**

*The study of science and engineering should produce a sense of the process of argument*

*necessary for advancing and defending a new idea or an explanation of a phenomenon and the norms for conducting such arguments. In that spirit, students should argue for the explanations they construct, defend their interpretations of the associated data, and advocate for the designs they propose. (NRC Framework, 2012, p. 73)*

Argumentation is a process for reaching agreements about explanations and design solutions. In science, reasoning and argument based on evidence are essential in identifying the best explanation for a natural phenomenon. In engineering, reasoning and argument are needed to identify the best solution to a design problem. Student engagement in scientific argumentation is critical if students are to understand the culture in which scientists live, and how to apply science and engineering for the benefit of society. As such, argument is a process based on evidence and reasoning that leads to explanations acceptable by the scientific community and design solutions acceptable by the engineering community.

Argument in science goes beyond reaching agreements in explanations and design solutions. Whether investigating a phenomenon, testing a design, or constructing a model to provide a mechanism for an explanation, students are expected to use argumentation to listen to, compare, and evaluate competing ideas and methods based on their merits. Scientists and engineers engage in argumentation when investigating a phenomenon, testing a design solution, resolving questions about measurements, building data models, and using evidence to evaluate claims.

### **Argumentation in Grade 3-5**

Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s).

- Compare and refine arguments based on an evaluation of the evidence presented.
- Distinguish among facts, reasoned judgment based on research findings, and speculation in an explanation.
- Respectfully provide and receive critiques from peers about a proposed procedure, explanation, or model by citing relevant evidence and posing specific questions.
- Construct and/or support an argument with evidence, data, and/or a model.
- Use data to evaluate claims about cause and effect.
- Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.

### **NGSS Performance Expectations with Explanation & Argumentation connections**

*(These are here as a reference so you can see how some NGSS Performance Expectations contain integrated explanation and argumentation practices)*

\_\_\_\_\_ 3-PS2-2 Make observations and/or measurements of an object's motion to provide evidence that that a pattern can be used to predict future motion.

\_\_\_\_\_ 3-LS2-1 Construct an argument that some animals form groups that help members survive.

\_\_\_\_\_ 3-LS3-2 Use evidence to support the explanation that traits can be influenced by the environment.

\_\_\_\_\_ 3-LS4-2 Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.

\_\_\_\_\_ 3-LS4-3 Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.

\_\_\_\_\_ 3-LS4-4 Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.

\_\_\_\_\_ 3-ESS3-1 Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.

\_\_\_\_\_ 4-PS3-1 Use evidence to construct an explanation relating the speed of an object to the energy of that object.

\_\_\_\_\_ 4-LS1-1 Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

\_\_\_\_\_ 4-ESS1-1 Identify evidence from patterns in rock formations and fossils in rock layers for changes in a landscape over time to support an explanation for changes in a landscape over time.

\_\_\_\_\_ 5-PS2-1 Support an argument that the gravitational force exerted by Earth on objects is directed down.

\_\_\_\_\_ 5-LS1-1 Support an argument that plants get the materials they need for growth chiefly from air and water.

\_\_\_\_\_ 5-ESS1-1 Support an argument that the apparent brightness of the sun and stars is due to their relative distances from the Earth.

Use the questions below to guide your thinking about how to effectively integrate the teaching of **Scientific Explanation and Argumentation** writing into your instructional materials.

Part 2. Identify the High Leverage Lesson	Facilitator NOTES
<p><b>Step 1:Examining your instructional material- Science Concepts</b>  <b>identify the science concepts and authentic opportunities for engaging in explanation.</b>            What are the important science concepts?            What are the relevant WA Science Standards in the lesson/unit?</p>	<p>Invite the STEM Professional to discuss:</p> <ul style="list-style-type: none"> <li>the important science concepts in the identified activities</li> <li>how explanation and argumentation present themselves in the “science world”</li> </ul> <p>A starting place has already been provided for each kit. Start in these places and confirm whether an opportunity is present.</p>
<p><b>Step 2: Examining your instructional material- Practices</b>            Where are the authentic opportunities for students to make claims, gather evidence, and use scientific reasoning (related to the important science concepts)?            What opportunities might students have to construct explanations and engage in argumentation?</p>	<p>Consider opportunities for students to make observations and collect data with the materials they have</p>
Part 3. Clarify the Explanation Opportunity	
<p><b>Step 1: Design the Question</b>            The wording of the question is very important and helps determine the difficulty and the level of complexity of the resulting explanation.            Is there an opportunity to collect evidence to answer the question?            Does the question require the use of a scientific concept in the reasoning?            Example- Thinking about the “openness” of a question:            Does water cause a seed to begin growing? (simple)            What does a seed need to begin growing? (complex)</p>	<p>This initial examination of the question is critical and will determine whether there is an enhancement opportunity and if so, how much supplementation will be required.</p>

<b>Step 2: Generate a Range of Claims</b> Brainstorm a range of claims from a high quality claim to the minimum acceptable claim. Include some incorrect or naive claims that some learners may have.	
<b>Step 3: Identify Acceptable Evidence</b> What evidence will students use to support their claim? How much evidence should students use? What incorrect evidence may some students be tempted to use? Why?	
<b>Step 4: Identify Reasoning</b> What type of reasoning might students use to connect their evidence to the claim? What science concepts (principles) will students be using?	If there is no science concept necessary in the reasoning then this may not be an ideal context for explanation and argumentation enhancement
<b>Step 5: Considering Rebuttal (optional)</b> What might a student use as a rebuttal to support the claim? Do you feel students are ready for this element of the CER(R) framework? Why/why not? How might you support students in crafting a rebuttal statement in their explanation?	
<b>Part 4: Develop the Assessment Task (performance task)</b>	
<b>Step 1: Select scientific explanation level of complexity</b> What variation of the CER framework will you use?	

See p. 118 WYE	
<b>Step 2: Create Learning Performances</b> see p. 121 WYE	
<b>Step 3: Write the Assessment Task</b> see p. 122 WYE	
<b>Step 4: Develop Specific Rubric</b> see p. 126 WYE	
<b>Part 5: Plan the Learning Sequence</b>	Now that you have the assessment task identified, work backwards to plan a learning sequence for scientific explanation writing (and talking).
<b>Step 1: Identify a Learning Sequence</b> Use some or all of the strategies below to create a Learning Sequence. How might you: <ul style="list-style-type: none"> <li>• Introduce the CER framework</li> <li>• Model and critique explanations</li> <li>• Provide a rationale for explanations</li> <li>• connect to everyday explanations</li> <li>• provide feedback to students on their explanations</li> </ul> How do you want to order your existing instructional activities for students to build evidence for their claims?	Reminder: We are not building an entire unit on Claim, Evidence, Reasoning. Be on the lookout for groups who are spending too much time and energy here.

<b>Step 2: Identify CER Tools and Strategies</b> - Which of the <a href="#">CER Tools &amp; Strategies</a> will be the most useful for supporting learners leading up to the performance task? Why do you think so?	
<b>Step 3: Unburden the Curriculum</b> What lessons or activities might you remove to make room for the enhancements?	
<b>Step 4: Supporting All Learners</b> How can we tailor instruction to students who may have special needs, interests, and abilities? <i>(Explanation and Argumentation have a strong connection to language learning- How will you support English Language Learners in the speaking, listening, and writing of Claim, Evidence, and Reasoning?)</i>	
<b>Step 5: Additional Notes and Resources</b> What additional information do you want to make sure and remember when you are ready to teach these lessons? What other resources might be useful for supporting teachers and/or learners during these lessons?	